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PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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MISSOURI HEADWATERS BASIN
PEAR LAKE DAM
BEAVERHEAD COUNTY, MONTANA
MT-820

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PREPARED FOR:

HONORABLE TED SCHWINDEN
GOVERNOR, STATE OF MONTANA

BEAVERHEAD WATER COMPANY
(OWNER/OPERATOR)

PREPARED BY:
HOSKINS-WESTERN-SONDEREGGER, INC.

MARCH, 1981

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EXECUTIVE SUMMARY

Under contract with the Seattle District Corps of Engineers and with representation from the owner and the Montana Department of Natural Resources and Conservation, Pear Lake Dam was inspected by Hoskins-Western-Sonderegger, Inc., on 20 September 1979 under the authority of Public Law 92-367. Pear Lake Dam is located in Beaverhead County, Montana, approximately 22 miles northwest of Dillon.

This report was compiled from information obtained during an on-site inspection, a review of operation records, and analysis of hydrologic and hydraulic data. Findings were compared to engineering criteria currently accepted by most private and public agencies engaged in dam design, construction, and operation.

PRINCIPAL FINDINGS AND EVALUATIONS

Pear Lake Dam is one of four dams in the Birch Creek watershed, owned and operated by the Beaverhead Water Company, which are used for irrigation storage. The other dams are Anchor Lake Dam and Tub Lake Dam, which are upstream of Pear Lake Dam, and Boot Lake Dam, which is downstream of Pear Lake Dam. The Pear Lake project consists of a natural lake and an embankment to raise the lake elevation for irrigation storage. The reservoir has a drainage area of 1.47 square miles (including upstream reservoirs), a surface area of about 48 acres at normal pool, and storage at dam crest of 481 acre-feet. The project is operated under a Department of Interior easement which was filed under the Public Lands Act of March 3, 1891.

In accordance with the "Recommended Guidelines for Safety Inspection of Dams" (Ref. 1), the 19-foot-high Pear Lake Dam (MT-820) is classified as being of small size and as having a significant (Category 2) downstream hazard potential, due to the presence of approximately 2 inhabitable structures located about 10 miles downstream from Boot Lake, along Birch Creek. It was assumed that discharges from a breach of Pear Lake Dam could not be contained by Boot Lake.

Inspection criteria (Ref. 1) recommend that a small-sized project with a significant downstream hazard potential be capable of safely handling a spillway design flood (SDF) in the range of the 100-year flood to one-half the probable maximum flood (PMF). The PMF is the flood expected from the most severe combination of meteorologic and hydrologic conditions that are reasonably possible in the region. Since Boot Lake Dam is located downstream from Pear Lake and is classified as being intermediate in size and, therefore, required to handle at least one-half of the PMF, we recommend that Pear Lake Dam also be able to handle one-half of the PMF.

During the dam safety analysis, an estimated PMF was developed for the drainage basin resulting from a 24-hour storm. The resulting PMF for the entire 1.47-square-mile watershed has a volume of approximately 1550 acre-feet. The reservoir level at the beginning of the 24-hour storm was

assumed to be at the spillway crest elevation. Infiltration losses were assumed to be zero. Reservoir routings of the estimated 24-hour PMF indicate that the project will handle about 17% of the PMF volume before overtopping if the low-level outlet is fully closed or about 19% of the PMF volume before overtopping if the low-level outlet is fully open. The dam is constructed of materials that would probably erode and fail when overtopped by flood waters. Discharges due to overtopping of the dam were included in the inflow hydrograph for Boot Lake Dam.

On the basis of the field inspection and the study of hydrologic and operational data, Pear Lake Dam does not conform to Corps guidelines with respect to discharge and/or storage capacity to safely handle the recommended SDF.

Evidence of foundation or abutment seepage was found at the maximum embankment section and near the left abutment. Evidence of concentrated seepage through the embankment was found above the low-level outlet headwall. This seepage could lead to embankment failure by piping. No piezometers are installed to measure water levels in the embankment, and there is no known internal drainage system. It is our judgment that the dam may conform with inspection guidelines for slope stability; however, seepage exists and sufficient information is not presently available to completely evaluate embankment stability.

PRINCIPAL RECOMMENDATIONS

Due to storage between the normal pool and the dam crest, the present project provides a degree of flood protection to the downstream area. The intent of report recommendations is to maintain or improve project safety, if feasible, without decreasing this existing flood protection.

A downstream warning plan, for use in the event of possible embankment failure, needs to be developed and placed into operation immediately. The conduit inlet and outlet structure wing walls need to be repaired or replaced. The concrete spillway structure needs to be repaired. A formal maintenance plan needs to be established and followed.

A discussion of all of the many alternatives which exist for failure or overtopping of the dams and reservoirs in this watershed and the responses to these failures or overtoppings by downstream dams and reservoirs is very complex and beyond the scope of this preliminary study. It is recommended that additional, more-detailed studies be initiated on this watershed so that a better understanding of the complex situation is achieved. Modify the project as the studies indicate.

Analyses should be performed by a qualified geotechnical engineer, experienced in dam design and construction, to determine if embankment modifications are required to provide adequate stability. Modify the project the project as the studies indicate.

Prior to performing engineering studies and remedial construction, coordinate all work with the U.S. Forest Service and the Montana Department of Natural Resources and Conservation to insure compliance with all laws and regulations.

Stephen H. Nickel
Professional Engineer

PERTINENT DATA

1. GENERAL

Federal I.D. No.	MT-820
Owner	Beaverhead Water Company
Operator	Beaverhead Water Company
Purpose	Irrigation
Location	Section 5, T5S, R11W Beaverhead County, Montana
Watershed	Birch Creek
Downstream Hazard Potential	Significant
USGS Quadrangle	Torrey Mountain, Montana; and Polaris, Montana

2. RESERVOIR

Surface Area at Normal Pool (Top of Timber Flashboards)	48 acres
Normal Storage (Top of Timber Flashboards)	356 acre-feet
Total Storage (Minimum Dam Crest)	481 acre-feet
Surcharge Storage	125 acre-feet
Drainage Area	1.47 square miles
Reservoir Water Surface Elevation (September 20, 1979)	8667.5 feet (NGVD)

3. SPILLWAY

Type	Uncontrolled earth and rock channel with concrete crest structure and timber flashboards
Crest Elevation (Top of Timber Flashboards)	8681.9 feet (NGVD)
Crest Elevation (Concrete Crest Structure)	8680.5 feet (NGVD)
Width	25 feet
Spillway Capacity (Minimum Dam Crest)	378 cfs

4. OUTLET WORKS

Type	Riveted steel pipe
Controls	Slide gate with manual controls located on dam crest
Size	2 pipes, both 18-inch diameter
Length	152 feet
Inlet Invert	8667.4 feet (NGVD)
Outlet Invert	8665.9 feet (NGVD)
Normal Tailwater	Unknown
Discharge Capacity (Minimum Dam Crest)	59 cfs

5. DAM

Type	Earth with concrete core wall
Maximum Height (Hydraulic)	19 feet
Crest Length	520 feet
Minimum Crest Elevation	8684.5 feet (NGVD)
Crest Width	50 feet
Upstream Slope (Except for Maximum Section)	1(V) on 2.5(H)
Upstream Slope (Maximum Section)	1(V) on 3.3(H)
Downstream Slope (Except for Maximum Section)	1(V) on 3(H)
Downstream Slope (Maximum Section)	1(V) on 4.8(H)

CHAPTER 1

BACKGROUND

1.1 INTRODUCTION

1.1.1 Authority and Scope

This report summarizes the Phase I inspection and evaluation of Pear Lake Dam, owned and operated by the Beaverhead Water Company of Dillon, Montana.

The National Dam Inspection Act, Public Law 92-367 dated 8 August 1972, authorized the Secretary of the Army, through the Corps of Engineers, to conduct safety inspections of non-federal dams throughout the United States. Pursuant to that authority, the Office of the Chief of Engineers issued "Recommended Guidelines for Safety Inspection of Dams" (Ref. 1) in May 1975.

The recommended guidelines were prepared with the help of engineers and scientists, highly experienced in dam safety, from many federal and state agencies, professional engineering organizations and private engineering consulting firms. Consequently, the evaluation criteria presented in the guidelines represent the comprehensive consensus of the engineering community.

Where necessary the guidelines outline a two-phased study procedure for investigating and evaluating existing dam conditions so deficiencies and hazardous conditions can be readily identified and corrected. The Phase I study is:

(1) a limited investigation to assess the general safety condition of the dam;
(2) based upon an evaluation of the available data and a visual inspection;
(3) performed to determine if any needed emergency measures and/or if additional studies, investigations and analyses are necessary or warranted; and
(4) not intended to include extensive explorations or analyses or to provide detailed alternative correction recommendations.

The Phase II investigation includes all additional studies necessary to evaluate the safety of the dam. Included in Phase II, as required, should be additional visual inspections, measurements, foundation exploration and testing, materials testing, hydraulic and hydrologic analyses and structural stability analyses.

The authority for the Corps of Engineers to participate in the inspection of non-federally owned dams is limited to Phase I investigations with the exception of situations of extreme emergency. In these cases the Corps may proceed with Phase II studies but only to the extent needed to answer serious questions relating to dam safety that cannot be answered otherwise. The two phases of investigations outlined above are intended only to evaluate

project safety and do not encompass in scope the engineering required to perform design or corrective modification work. Recommendations contained in this report may be for either Phase II safety analyses or detailed design study for corrective work.

The responsibility for implementation of these Phase I recommendations rests with the dam owner and the State of Montana. It should be noted that nothing contained in the National Dam Inspection Act, and neither action nor failure to act under this Act shall be construed (1) to create liability in the United States or its officers or employees for the recovery of damage caused by such action or failure to act or (2) to relieve an owner or operator of a dam of the legal duties, obligations, or liabilities incident to the ownership or operation of the dam.

1.1.2 Purpose

The purpose of the inspection and evaluation is to identify conditions that threaten public safety, so that they may be corrected in a timely manner by non-federal interests.

1.1.3 Inspection

The findings and recommendations in this report were based on visual inspection of the project and an interview with the owners. Records of infrequent inspections, dating as far back as 1947, were furnished for reference. No design drawings or foundation exploration results were available for review or analysis. Inspection procedures and criteria were those established by the "Recommended Guidelines for Safety Inspection of Dams" (Ref. 1).

Personnel present during the inspection included:

Louis Boitano, Civil Engineer, Seattle District Corps of Engineers;
Art Taylor, Civil Engineer, State of Montana, Department of Natural Resources and Conservation; and
Garth Taylor, President, Beaverhead Water Company

Hoskins-Western-Sonderegger, Inc. (HWS) personnel who participated in the field inspection and contributed to this report are:

Stephen Nickel, Geotechnical Engineer, Team Leader;
Mike McMeekin, Hydrologist/Hydraulics Engineer; and
Gene Holtorf, Hydrologist/Hydraulics Engineer.

This report has been reviewed by representatives of the Beaverhead Water Company, the U.S. Forest Service, the Bureau of Land Management, and the Montana Department of Natural Resources and Conservation. Their written comments have been included in the Appendix of this report.

1.2 DESCRIPTION OF PROJECT

1.2.1 General

Pear Lake is one of four high mountain lakes owned and operated by the Beaverhead Water Company, which are used to store snowmelt and runoff for irrigation. It is operated under a Department of Interior easement which was filed under the Public Lands Act of March 3, 1891. Anchor Lake (drainage area = 0.46 square miles) and Tub Lake (drainage area = 0.25 square miles) drain into Pear Lake (local drainage area = 0.76 square miles), which drains into Boot Lake (local drainage area = 1.53 square miles). The total area of the watershed is approximately 3.0 square miles.

Pear Lake Dam (MT-820) is located in Section 5, Township 5 South, Range 11 West, Beaverhead County, Montana, approximately 22 miles northwest of Dillon, on Birch Creek. Pear Lake's natural storage capacity of approximately 20 acre-feet was increased to its present size with the construction of Pear Lake Dam in 1904. A 25-foot-wide uncontrolled spillway for the facility is located in the embankment, near the left abutment of the dam. The dam has a pair of 18-inch-diameter riveted steel pipe, low-level outlet conduits, which are used to control the amount of discharge from the lake during the irrigation season.

Pear Lake Dam is 19 feet high and, at the minimum dam crest elevation of 8684.5 feet, impounds 481 acre-feet of water with a surface area of about 48 acres. Based on a visual reconnaissance and engineering judgment, approximately 2 inhabitable structures located about 10 miles downstream from Boot Lake, along Birch Creek, could be affected by a sudden breach of Pear Lake Dam. The dam, therefore, is classified as small in size and as having a significant downstream hazard potential.

1.2.2 Regional Geology

The Pioneer Mountains lie in the southwest corner of Montana. They are bounded by the Anaconda Range to the north, the Beaverhead Mountains in the Bitterroot Range to the west across the Big Hole Valley, and the Ruby and Tobacco Root Ranges to the east across the Beaverhead Valley.

The Pioneer Mountains are essentially composed of a complex suite of igneous rocks, the Boulder Batholith, which has intruded into the much older sedimentary and metamorphic rocks of the area. The intrusion of the Boulder Batholith, along with intensive block and thrust faulting, has been the major factor in the geologic structure of the Pioneer Mountains. Present topography is the result of Pleistocene glaciation and valley fill in the lower intermountain areas.

The northern Rocky Mountain region, prior to Late Cretaceous time, was essentially a flat plain partially flooded by shallow seas. At the end of the Mesozoic Era, of which the Cretaceous is the last geologic epoch, this entire area became geologically active. Three things exemplify this activity:

(1) Cretaceous uplift;
(2) Late Cretaceous thrust faulting; and
(3) Late Cretaceous-Tertiary intrusive activity, i.e., the Boulder Batholith.

The regional uplifting of the continental crust brought the earth up in several north-south trending blocks. The west sides of the faulted blocks, or mountains, are higher in elevation and have characteristically abrupt scarps, while the east sides of the blocks have long, gentle slopes.

The uplifted land became subjected to erosion. As the sediments were transported downslope, they filled the intermountain valleys with debris ranging from muds and sands to gravels and cobbles. These valley-fill sediments attain a depth of several thousand feet in the axis of the mountain valleys.

Pleistocene alpine glaciation of Wisconsin Age (12,000 years before present) sculptured typical alpine glacial features including cirques, headwalls, and troughs in the upper elevations of the Pioneer Mountains. In lower elevations, glacial deposits of terrace gravel, stream bed alluvium, landslide rubble, and glacial drift occur.

1.2.3 Seismicity

Pear Lake Dam (MT-820), located in the Pioneer Mountains, lies in Seismic Zone 3 as indicated by the Seismic Zone Map (Ref. 1). The seismic probability of this regional setting is one of potential for major damage and is based on the known distribution of damaging earthquakes in the region.

The Preliminary Map of Young Faults in the United States, by the U.S. Geological Survey (Ref. 2), indicates suspected activity along the northern expanse of the Pioneer Mountains and Holocene activity directly east, along the northwestern side of the Tobacco Root Range. The Geologic Map of Montana shows extensive faulting prior to the Cenozoic Era in the southern portions of the Pioneer Mountains.

Local earthquakes significant enough to be reported in References 3 and 4 occur in 2 epicentral areas. One of these is to the northeast along a line from 20 miles northwest of Helena to 25 miles north of Bozeman, while the other is to the southeast in northeast Idaho, northwest Wyoming, and the adjoining areas of Montana. Of these two epicentral areas, the former is 75 to 100 miles northeast and the latter is 50 to 150 miles southeast of the project site. Two earthquakes of significant intensity that occurred in the tri-state region southeast of the project site were the Hebgen Lake, Montana, earthquake (8 August 1959) that had an intensity of X (Modified Mercalli) and another, southeast of Dillon, Montana, and southeast of the project area (23 November 1947), that had an intensity of VIII. The three largest reported earthquakes northeast of the Pioneer Mountains have had intensities of VIII. One of these earthquakes had its epicenter at a point 25 miles north of Bozeman (27 June 1925), while the other two occurred at Helena (18 October and 31 October 1935).

In the vicinity of the project there have been numerous other earthquakes in this century (Ref. 3 and 4). In an area bounded by the 44th and 46th parallels and by the 110th and 112th meridians (including the tri-state region), there have been more than 50 earthquakes with intensities of V and more than 10 with an intensity of VI. The closest reported earthquakes to the project site have occurred approximately 50 miles east near Ennis and Virginia City, Montana. The largest of these had an intensity of VI and occurred near Ennis (10 March 1977). The exact distance from the epicenter of this earthquake to the project site is not known.

The Pioneer Mountains lie in a highly seismically active area with the potential for a damaging earthquake. This warrants special attention be given to the dams that are in the area and that have been constructed without consideration of the effects of earthquakes.

1.2.4 Site Geology

Pear Lake is a glacial lake. Specifically, it is a small body of water occupying a cirque depression (cirque lake) dammed by a rock lip, small moraine, or both. Very steep cirque headwalls (slopes of 60% to 80%) and strongly scoured glacial troughwalls comprise the local terrain. A thin mantle of weathered rock with almost no soil development is typical of the area. Where soil development has begun, the soil is characterized as patchy, very shallow silt loams and sandy loams. Typical mass-wasting features such as talus slopes and rock glaciers, characteristic of very strongly scoured cirque basins, are present. Igneous and metamorphic rocks comprise the regional bedrock.

1.2.5 Design and Construction History

According to State of Montana records, Pear Lake Dam was completed in 1904. Construction was supervised by George Metlin, Chief Engineer for Justin E. Morse, Contractor. As plans are not available, nothing is known about the placement of material in the dam. The existing low-level outlet pipes appear to have been placed during the construction of the dam. The embankment appears to contain a concrete core wall.

CHAPTER 2

INSPECTION AND RECORDS EVALUATION

2.1 HYDRAULICS AND STRUCTURES

2.1.1 Spillway

The spillway for Pear Lake is in the embankment, near the left abutment of the dam. The spillway is an uncontrolled, excavated earth and rock channel with a concrete crest structure. It can be best seen in Photos 10 through 12. Approximate dimensions and elevations were determined in the field for use in the calculation of the discharge capacity of the spillway.

The control section for the spillway is a 1.4-foot-high weir composed of 2 timber flashboards, which are located at the upstream end of the concrete crest structure. The crest elevation of the timber flashboards, 8681.9 feet, is 2.6 feet below the minimum crest elevation of the dam, 8684.5 feet, while the crest elevation of the concrete structure, 8680.5 feet, is 4.0 feet below the minimum crest elevation of the dam. The concrete structure is 25 feet wide, has concrete sides and a concrete center pier which are approximately 4.4 feet high, and is approximately 13 feet long (Photos 10 through 12). The spillway downstream from the concrete structure is an excavated earth and rock channel (Photo 13), with a slope of approximately 1.8%. The excavated channel is approximately 35 feet wide and 1.5 feet deep and serves to contain low flows which pass through the concrete structure. Higher flows, which exceed the capacity of the channel, spread over a broad area of natural ground and flow down the natural slope toward Boot Lake (Photo 13). The timber flashboards have been in place since 1961, according to U.S. Forest Service inspection reports, and, thus, were assumed to be a permanent part of the spillway for determining the discharge capacity of the spillway in this report.

The discharge rating curve (Plate 6) was computed by assuming that the timber flashboards act as a sharp-crested weir. The discharge capacity of the spillway at the minimum crest elevation of the dam is approximately 380 cfs.

The spillway channel appears to be in generally good condition with slight erosion just downstream from the concrete crest structure. The spillway approach channel is filled with debris, and the log boom is no longer functional. For the computation of the spillway rating curve, the spillway was assumed to be free of debris. Blockage of the spillway by debris would reduce spillway capacity and project performance.

2.1.2 Outlet Works

The low-level gravity outlet through the dam consists of a pair of 18-inch-diameter riveted steel pipes (Photo 14 - inlet, Photos 16 and 17 - outlet). The length of each outlet pipe is approximately 150 feet. Operating controls are located on the crest of the dam (Photo 15). Because the wooden structure on the top of the gate tower was not removable, inspection of the control

mechanisms was impossible at the time of the inspection; however, it was assumed that vertical slide gates are used to control the rate of flow through the pipes. A sketch of the dam cross section which includes the outlet pipes is shown on Plate 3. The inlet invert elevation of both pipes is 8667.4 feet, which is 17.1 feet below the minimum crest elevation of the dam and 14.5 feet below the normal pool elevation (top of timber flashboards). The outlet invert elevation of both pipes is 8665.9, and the resulting slope of both pipes is approximately 1.0%.

A visual inspection of the upstream end of the outlet pipes revealed that the concrete inlet structure was in good repair (Photo 14). The inlet was open and free of debris; however, the absence of an adequate trash rack may result in the inlet being plugged by debris when the reservoir is at a higher level. The downstream ends of the outlet pipes are also encased in a concrete structure. One wing wall of the structure is broken off, but this does not appear to affect the operation of the outlet pipes or the stability of the dam embankment (Photos 16 and 17). Both outlet pipes show signs of corrosion at both inlet and outlet ends, but do not appear to be rusted through. The interior portions of the outlet pipes were not inspected.

The discharge rating curve for the outlet pipes (Plate 7) was computed assuming full pipe flow discharge with vertical slide gates on the pipes completely raised. The combined discharge capacity for the two 18-inch-diameter pipes is approximately 55 cfs at the normal pool elevation and 59 cfs at the minimum crest elevation of the dam.

2.1.3 Freeboard

The effective fetch for wind-generated waves is about 1600 feet, and the wave run-up and set-up on the embankment is estimated to be 1.9 feet (Ref. 5). At the normal pool elevation of 8681.9 feet, an approximate 2.6-foot vertical difference exists between the pool elevation and the minimum dam crest elevation. This is considered marginal in preventing wave overtopping (Ref. 6).

At the time of inspection, the lake had been drained to its natural level, and the pool elevation was approximately 14.4 feet below the normal operating pool level of 8681.9 feet. Under these conditions, the vertical distance was adequate to prevent wave overtopping. Routings indicate that no freeboard exists during the recommended SDF.

2.2 HYDROLOGY, CLIMATOLOGY, AND PHYSIOGRAPHY

2.2.1 Climatology and Physiography

The climate of the area around Pear Lake is continental and characterized by a large diurnal and seasonal temperature range. Extreme variability of wintertime temperatures results from the frequent occurrence of chinook winds, which follow a Pacific maritime air mass invasion. Summers are characterized by warm days with low humidity and cool nights. Winters are cold and highly variable in severity from year to year and within a given year.

Dillon, in Beaverhead County, at an elevation of 5218 feet, is the climatological station nearest the project site. The precipitation and climatological data available from this station are not applicable to the project because of a 3586-foot elevation difference between Pear Lake and the weather station. The average annual precipitation at Pear Lake, as estimated from Soil Conservation Service graphs, is over 40 inches (Ref. 7). At the project site, the expected date of the first freeze is August 13th, and the expected date of the last freeze is July 9th (Ref. 8).

Pear Lake Dam is located on Birch Creek in the Pioneer Mountains and is in the Beaverhead National Forest. The drainage basin above and including Pear Lake has an area of about 1.47 square miles. Basin elevations range from the normal pool elevation of 8681.9 feet to 10,431 feet on top of Highboy Mountain. The average ground slope is about 22%. Basin vegetation consists of moderately thick pine and grasses on the lower basin area to sparse pine and rocky surfaces on the upper basin area (see Photos 1 and 2).

2.2.2 Reservoir Storage and Spillway Discharge

The reservoir has a surface area of about 48 acres and a storage of about 356 acre-feet at the spillway crest elevation of 8681.9 feet. Approximately 125 acre-feet of storage are available between this spillway crest and the minimum crest elevation of the dam, 8684.5 feet. The spillway discharge at the minimum dam crest, with the arrangement of flashboards observed during the inspection, is approximately 380 cfs. The discharge capacity of the facility would increase an additional 59 cfs if the control gates for the low-level outlets were opened.

2.2.3 Estimated Probable Maximum Flood

The probable maximum flood (PMF) is the flood expected from the most severe combination of critical meterologic and hydrologic conditions that are reasonably possible in the region. A storm, the intensity of which approached probable maximum precipitation (PMP) intensity, did occur in parts of Montana in June 1964.

Inspection criteria (Ref. 1) recommend that a small-sized project with a significant downstream hazard potential be capable of handling a spillway design flood (SDF) in the range of the 100-year flood to one-half of the PMF. Because of the involved risk for this project, we recommend that the SDF be one-half of the PMF.

A probable maximum precipitation (PMP) storm of 24-hour duration was applied to the basin. The 24-hour, 12-hour, 6-hour, and 1-hour PMP depths were estimated from National Weather Service Technical Paper 38 (Ref. 9) to be 15.1 inches, 12.8 inches, 10.4 inches, and 6.4 inches, respectively. All 6-hour increments from 0 to 24 hours were arranged in accordance with criteria in Weather Bureau Hydrometeorological Report No. 43 (Ref. 10).

The probable maximum flood was assumed to result from a PMP storm in the late spring, over hard and frozen ground; thus, a constant soil loss rate

of zero was applied throughout the 24-hour PMP storm in accordance with Corps of Engineers recommendations. Thus, the overall configuration of the 24-hour storm is not affected by losses in the soil, and the basin rainfall is equal to the basin runoff for all storm increments. Direct precipitation onto the surface of the lake was also added with no losses.

In evaluating the PMF for Pear Lake, inflow from outlet pipes, spillway discharges, and dam breaches of Tub and Anchor Lakes, located upstream, were evaluated. These were added to the rainfall which fell directly upon the reservoir and in the basin to arrive at the total PMF for Pear Lake.

2.2.4 Flood Routing

For purposes of routing the PMF through Pear Lake, the lake level at the beginning of the PMP storm was assumed to be at the spillway crest elevation of 8681.9 feet. This would correspond to the normal pool condition. The total volume of the 24-hour PMF for Pear Lake, including flows from Tub and Anchor Lakes, is about 1550 acre-feet, with a peak flow rate of approximately 9100 cfs. Two routings were made. The first routing indicated that, with the control gates of the irrigation outlet closed, the project will handle, through storage and spillway discharge, approximately 17% of the PMF volume before the dam is overtopped. The second routing assumed the control gates on the outlet pipes to be completely open. This results in the project handling approximately 19% of the PMF volume before the dam is overtopped. Pear Lake Dam is constructed of materials that will probably erode and fail when overtopped by flood waters. The spillway and overtopping discharges from Pear Lake were included in the inflow hydrograph for Boot Lake.

The PMF inflow hydrographs were developed using the SCS dimensionless unit hydrograph. These hydrographs were generated and combined using the HEC-1 (Dam Safety Version) computer program (Ref. 11). The flood routings of the PMF were made using the Modified Puls method contained in the HEC-1 program.

2.3 GEOTECHNICAL EVALUATION

2.3.1 Embankment

The 19-foot-high earth dam is 520 feet long and has a crest width of 50 feet. The upstream slope is generally 1(V) on 2.5(H), flattening to 1(V) on 3.3(H) at the maximum section. The downstream slope is generally 1(V) on 3(H), flattening to 1(V) on 4.8(H) at the maximum section. Borrow for the embankment construction appears to have been obtained from areas above both abutments, primarily the right abutment, and from the area immediately downstream from the dam. The material exposed on the crest of the dam is a silty sand matrix, containing gravel and cobbles. This material is considered to be highly erodible. The upstream and downstream embankment slopes are covered with igneous rock riprap, generally ranging in size from 6 inches to 36 inches in diameter. No evidence was found of a granular bedding or filter course between the riprap and the finer embankment materials. The presence of sags or bulges on the upstream or downstream

faces could not be determined because of the varying slopes. No sags were visible on the crest.

A concrete core wall is incorporated in the embankment. It is located roughly 5 to 10 feet upstream from the embankment center line. Other details about the wall are unknown.

The only vegetated area of the embankment is the crest. The vegetation consists of approximately 50% coverage of native grasses, brush, and trees. The trees and brush range up to 10 feet tall (see Photos 7 and 8). In addition, there are several taller trees growing near the downstream toe (see Photos 5, 6, and 7).

2.3.2 Foundation Condition, Seepage, and Drainage

The dam is probably founded on soil similar to that used in the embankment itself. This silty sand material is considered to be quite pervious. The core wall appears to have been an effort by the designer to limit seepage. Forest Service records indicate a continual seepage problem above the conduit outlet headwall. This may indicate cracking or bypassing of the core wall. The core wall does not extend left of the concrete spillway structure. In this area, seepage at the downstream toe during periods of high pool level has eroded a channel roughly 2 feet wide and 6 inches deep (see Photo 7). This indicates a large quantity of seepage, even though the embankment in this area is only about 5 feet high.

There was no evidence to indicate that the dam embankment includes any type of internal drain or any instrumentation, such as piezometers.

2.3.3 Stability

It appears that there is considerable seepage near the left abutment and in the vicinity of the conduit outlet during periods of higher pool elevations. This seepage is the main threat to the stability of the embankment. Failure by piping caused by the gradual removal of embankment material appears as a possibility.

In our judgment the wide crest and relatively flat embankment slopes suggest that the dam probably conforms with inspection guidelines for slope stability. However, seepage exists, and insufficient information is available to completely evaluate stability.

2.4 PROJECT OPERATION AND MAINTENANCE

2.4.1 General

Operation and maintenance of Pear Lake and Dam is the responsibility of the Beaverhead Water Company, with technical assistance provided by the Forest Service. Although a formal plan for operation and maintenance of the lake and dam facilities is not known to exist, inspection reports going back more than 30 years infer the above responsibilities. In addition, the reports indicate the dam has had a history of maintenance problems.

Access to the project is difficult. This limits regular maintenance to those functions which can be performed by hand.

2.4.2 Dam

There is no formal plan for performing periodic maintenance on Pear Lake Dam. Inspection reports by the Forest Service and correspondence indicate a general lack of adequate maintenance for at least the last 30 years. Maintenance is needed particularly on the low-level inlet structure, the low-level outlet structure, and the concrete spillway crest structure.

2.4.3 Reservoir

The reservoir level fluctuates seasonally, being low in the winter, full by the start of the irrigation season, and low again by autumn. Water is obtained from snowmelt and rainfall. The release of irrigation water is controlled by valves on the twin outlet conduits.

As with the dam, the reservoir has no formal plan for operation and maintenance and has received very little attention for many years. A large amount of debris, mostly dead trees, covers the shore of the reservoir. This debris also is partially blocking the spillway approach channel and covers the upstream face of the dam at the high water line.

2.4.4 Warning System

There is no formal warning system or plan of action to warn downstream inhabitants or interests in the event of impending dam failure.

CHAPTER 3

FINDINGS AND RECOMMENDATIONS

3.1 FINDINGS

Visual inspection of Pear Lake and Dam, supplemented by analysis of the project in terms of the recommended guidelines' performance standards, resulted in the following findings.

3.1.1 Size, Hazard Classification, and Safety Evaluation

In accordance with inspection guidelines, Pear Lake Dam is classified as small in size and, based on our visual inspection and judgment, has a significant downstream hazard potential. The recommended spillway design flood (SDF) for this project is one-half of the PMF. Based on reconnaissance level investigations, the project is incapable of handling one-half of the PMF without overtopping. Therefore, Pear Lake Dam does not comply with inspection guidelines with respect to discharge and/or storage capacity.

3.1.2 Embankment Dam

As noted in Section 2.3, there is evidence of seepage at the maximum embankment section and near the left abutment. The seepage near the left abutment occurs where there is no concrete core wall. The seepage near the conduit outlet appears indicative of water bypassing the core wall or moving through cracks in the core wall. This seepage may lead to failure of the embankment by piping.

There is no known internal drainage system or instrumentation, such as piezometers, installed in the dam. Therefore, the location of the phreatic surface cannot be determined at this time.

Based on experience with similar structures and materials, it is our judgment that sufficient information is not presently available to adequately evaluate embankment stability.

3.1.3 Spillway

The earth and rock spillway channel was found to be in good condition with little erosion damage evident. The concrete crest structure, as best seen in Photos 10 through 12, shows some concrete deterioration. The concrete surfaces are generally eroded, with spalling in many locations and large cracks in the right side where the structure meets the core wall of the dam and on both sides where the wing walls flare out. Based on Forest Service reports, some repair work previously has been done to the structure, but none in the last few years. The spillway approach channel is filled with debris and the log boom is no longer functional. The timber flashboards, which act as a weir, decrease the flood surcharge storage capacity and spillway discharge capacity and should be removed.

3.1.4 Outlet Works

The twin 18-inch steel pipes are generally in good condition. There were signs of corrosion in the pipes, but they were not rusted through. The inlet to the pipes is open and free of debris; however, the lack of an adequate trash rack may result in the inlet being plugged by debris when the reservoir is operating at a higher level. The inlet structure headwall (Photo 14) has a large vertical crack extending from the top of the right outlet pipe to the top of the structure and another large horizontal crack from the right edge of the structure meeting the vertical crack about 18 inches above the top of the pipe. The top of the right wing wall for the inlet structure is tilted inward about 4 inches. It was not possible to inspect the valves because the wooden cover for the gate tower was not removable. Also, it was not possible to inspect the interior portions of the conduits. The gate tower cover is in fairly good repair. The valves were locked in an open position and are operational, according to Mr. Garth Taylor, President of the Beaverhead Water Company. One wing wall of the outlet structure is broken off. Although this poses no immediate threat to the integrity of the structure, future erosion may be possible.

3.1.5 Spillway and Reservoir Capacity

The lake storage capacity and spillway discharge capacity are insufficient to prevent overtopping of the dam during the recommended SDF. This investigation has estimated that, during the 24-hour PMP, the dam overtops when only 17% of the PMF volume has entered the reservoir. Debris blocking the spillway would reduce spillway discharge capacity and project performance.

3.1.6 Operation and Maintenance

Operation and maintenance are performed by the Beaverhead Water Company, with technical assistance provided by the Forest Service. There is no formal operation plan for the reservoir. Water from spring runoff and from releases out of upstream reservoirs is stored in the reservoir and is released from the outlet as needed for irrigation. Consequently, the lake level fluctuates seasonally.

There is no formal maintenance plan for the dam, and the facility has a history of inadequate maintenance. The debris in the spillway inlet, the poor condition of the low-level inlet and outlet structures, trees and brush on the crest, and the apparently unchecked seepage are all indications of the lack of sufficient recent maintenance.

There is no formal warning system or plan of action to warn downstream inhabitants in the event of impending dam failure.

3.2 RECOMMENDATIONS

Due to storage between normal pool and dam crest, the present project provides a degree of flood protection to the downstream area. The intent of report recommendations is to maintain or improve project safety without decreasing this existing flood protection.

1. Immediately develop, implement, and periodically test a downstream notification plan for use in the event of dam distress.

2. Clear the spillway and reservoir area of debris. Install an effective log boom to prevent spillway blockage.

3. Repair or replace the wing walls of the low-level inlet structure. Inspect the steel outlet pipes. Provide an adequate trash rack at the inlet structure.

4. Replace the right wing wall of the conduit outlet structure.

5. Remove the flashboards in the concrete spillway crest structure to provide greater flood surcharge storage and greater spillway discharge capacity.

6. Repair or replace all cracked, spalled, or eroded concrete on the spillway crest structure.

7. Remove the trees and their root systems from the crest of the embankment and adequately backfill and compact the resulting holes.

8. Conduct more-detailed hydrologic and hydraulic routing studies, involving all four of the Beaverhead Water Company's Birch Creek watershed dams, to better determine the downstream hazard and required spillway capacity. Modify the project as studies indicate.

9. Have a qualified geotechnical engineer, experienced in dam design and construction, determine if embankment modifications are required to provide adequate stability. Consider installing properly designed inverted filters over the seepage areas to prevent possible piping failure.

10. Develop and implement a periodic maintenance plan for the dam and appurtenant structures. Because of the remoteness of the project site, the maintenance plan should include frequent condition inspections whenever water is impounded.

11. Establish a program for periodic, comprehensive, safety inspections at no more than 5-year intervals. These inspections should be performed by engineers qualified in the design, construction, operation, and maintenance of earth dams.

Prior to performing engineering studies and remedial construction, coordinate all work with the U.S. Forest Service and Montana Department of Natural Resources and Conservation to insure compliance with all laws and regulations.

REFERENCES

1. U. S. Army Corps of Engineers, Office of the Chief of Engineers, Report to the U. S. Congress, National Program of Inspection of Dams, Vol. 1, Appendix D, "Recommended Guidelines for Safety Inspections of Dams", Washington D. C., Department of the Army, May 1975.

2. Howard, K. A., et al, "Preliminary Map of Young Faults in the United States as a Guide to Possible Fault Activity," U. S. Geological Survey, Reston, Virginia, 1978.

3. U. S. Geological Survey, "Earthquake Information Bulletin," Washington D. C., 1973-1978.

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5. U. S. Army Corps of Engineers, Office of the Chief of Engineers, "Wave Run-up and Wind Set-up on Reservoir Embankments," Engineer Technical Letter No. 1110-2-221.

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7. U. S. Department of Agriculture, Soil Conservation Service, "Average Annual Precipitation in Montana," Portland, OR, 1977.

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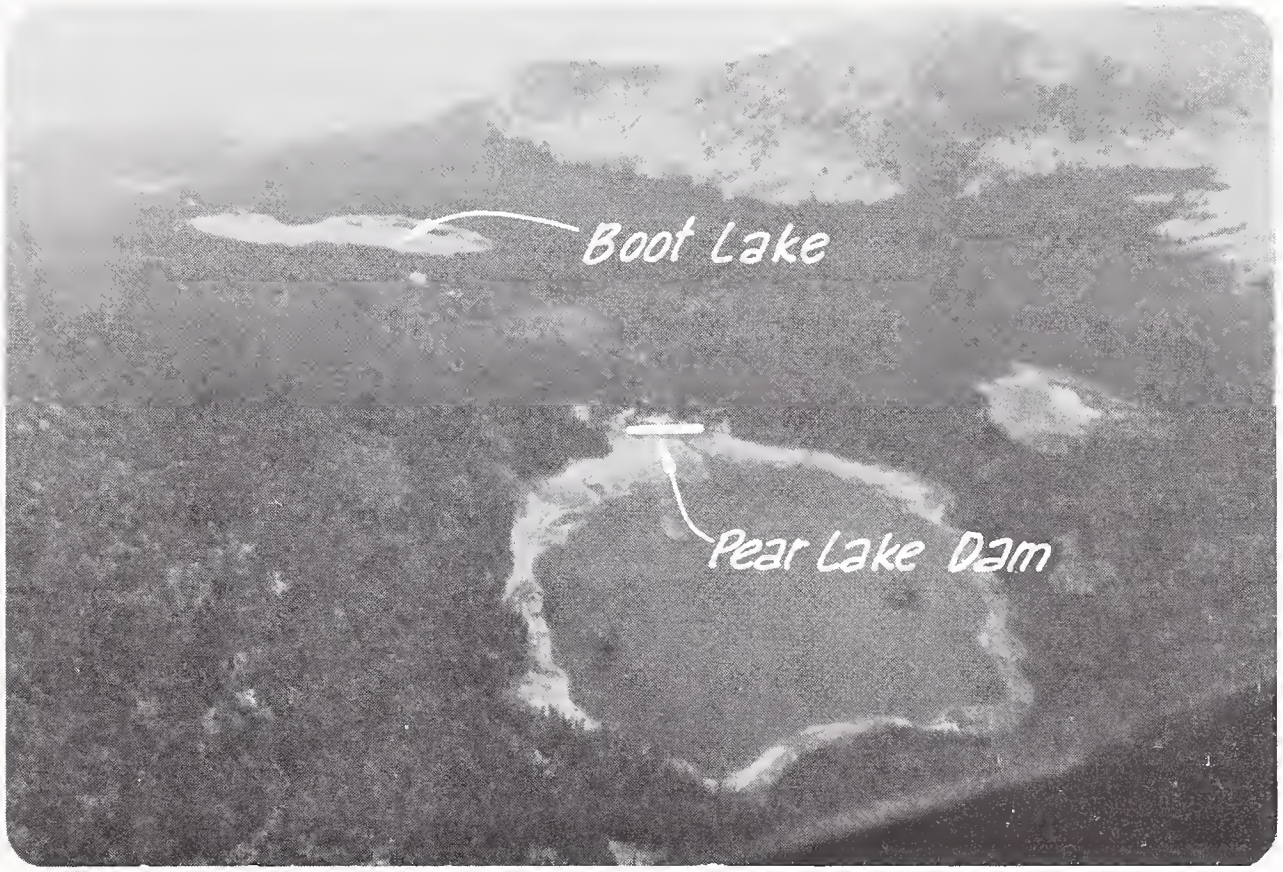
11. U. S. Army Corps of Engineers, Hydrologic Engineering Center, Flood Hydrograph Package (HEC-1), Users' Manual for Dam Safety Investigations, Davis, California, September 1978.



(PHOTO 1) Pear Lake and Dam, Aerial View

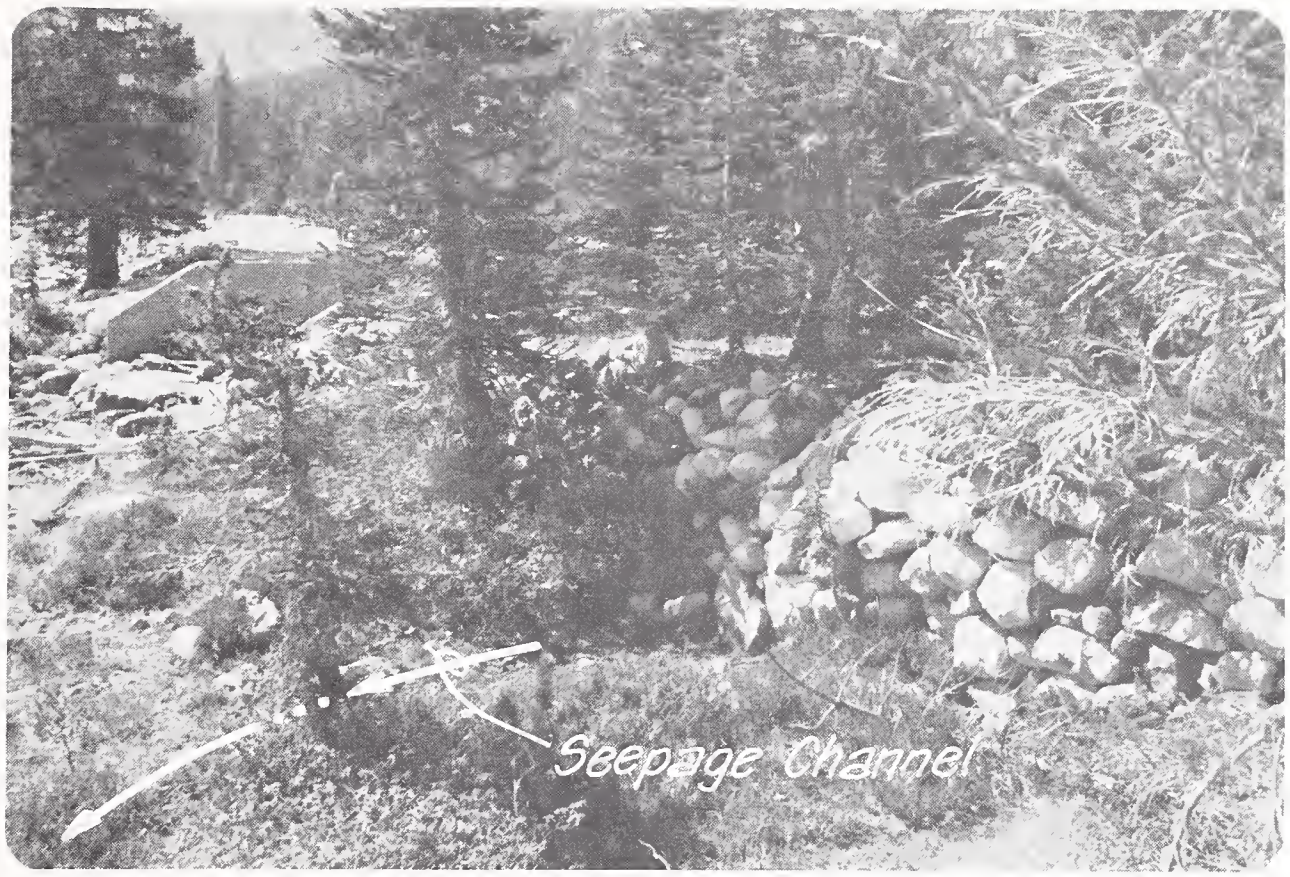
(PHOTO 2) Pear Lake and Drainage Area

(PHOTO 3) Upstream Face from Left Abutment

(PHOTO 4) Upstream Face from Right Abutment

(PHOTO 5) Downstream Face from Right Abutment

(PHOTO 6) Downstream Face and Spillway Outlet from Left Abutment



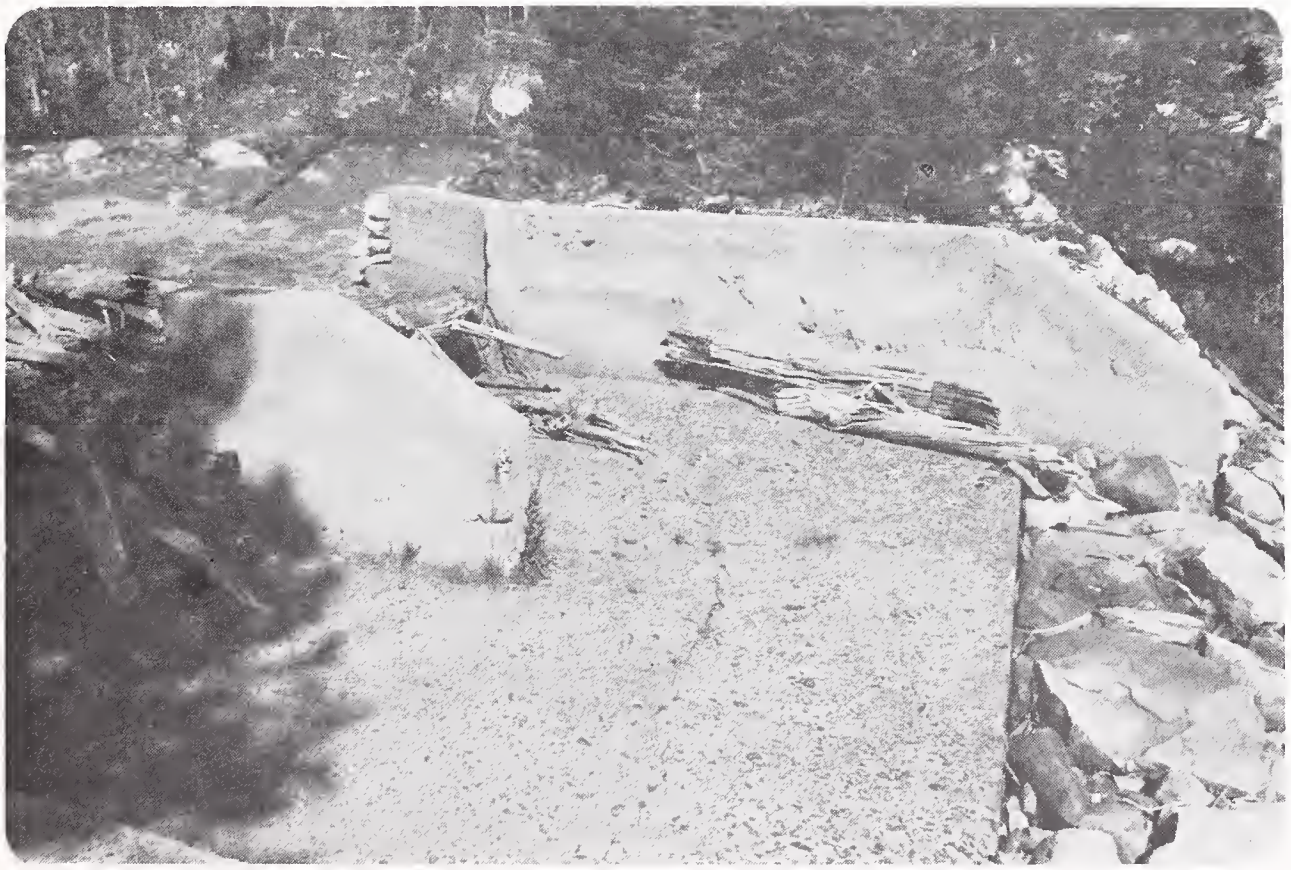
(PHOTO 7) Seepage Area near Left Abutment

(PHOTO 8) Dam Crest

(PHOTO 9) Spillway Approach Channel, Looking Downstream

(PHOTO 10) Spillway Structure - Downstream

(PHOTO 11) Spillway Structure - Right Side



(PHOTO 12) Spillway Structure - Left Side

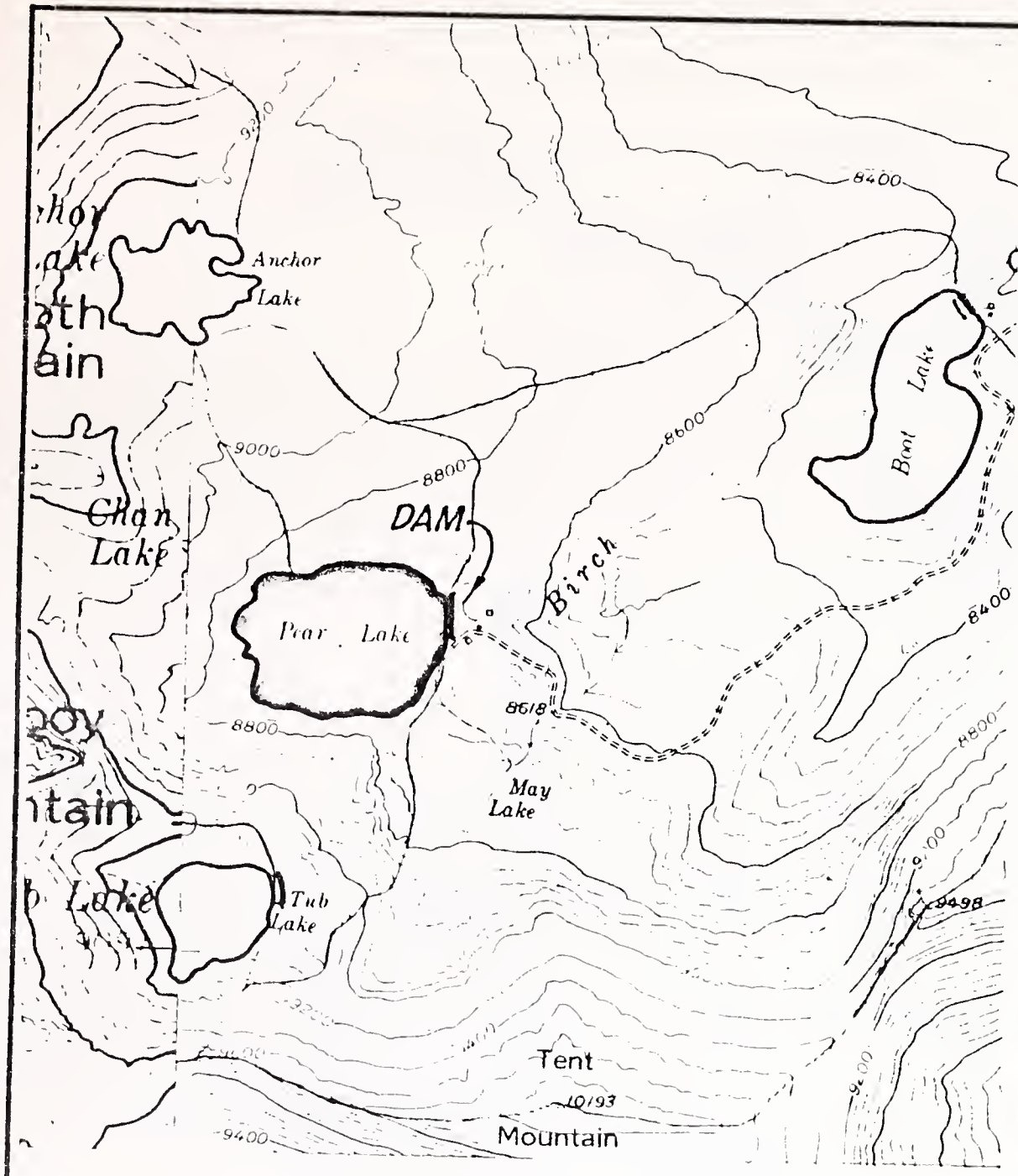
(PHOTO 13) Spillway Outlet Channel, Looking Downstream

(PHOTO 14) Conduit Inlet Structure

(PHOTO 15) Low-Level Outlet Controls

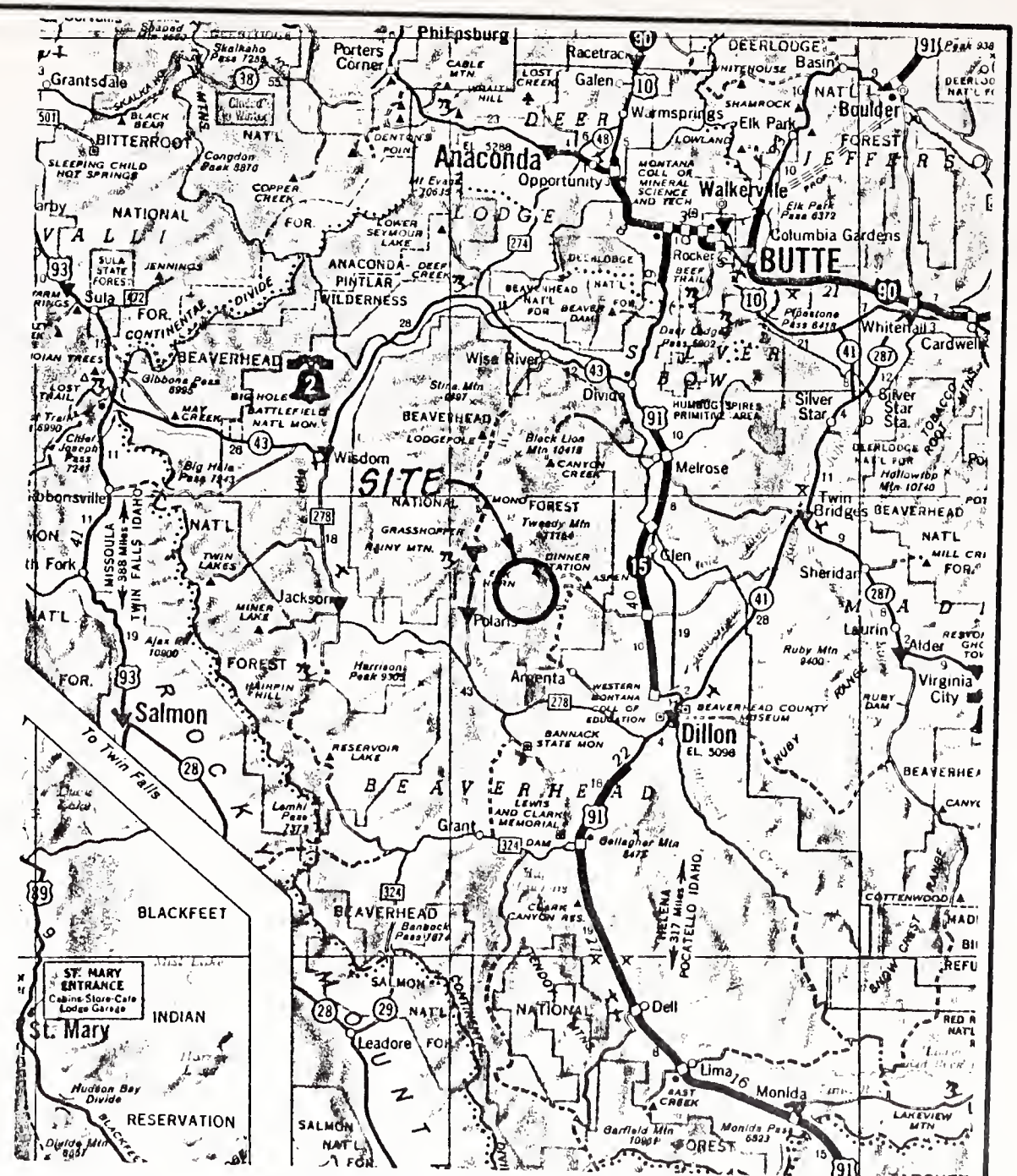
(PHOTO 16) Conduit Outlet Structure

(PHOTO 17) Conduit Outlet Structure and Downstream Face of Dam



SITE PLAN

N



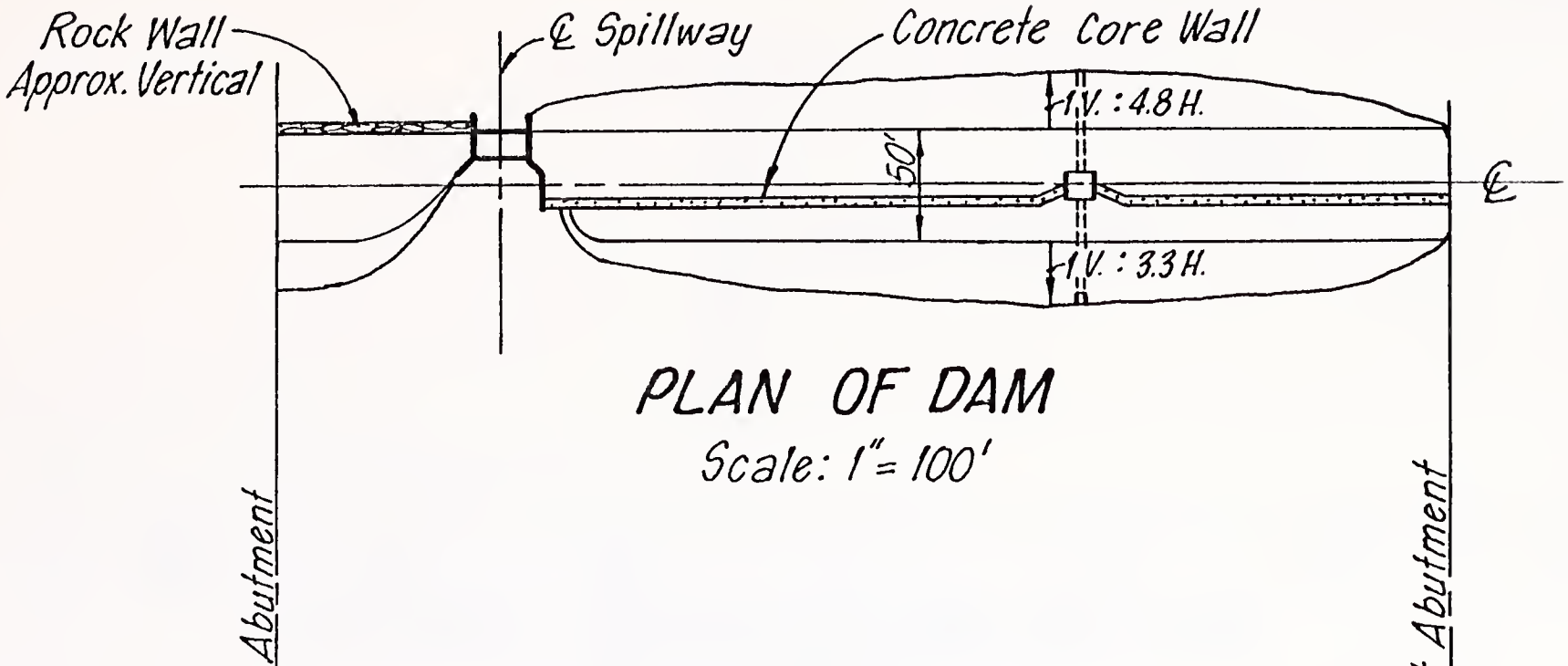
VICINITY MAP

PLATE 1

PEAR LAKE DAM (MT.-820)

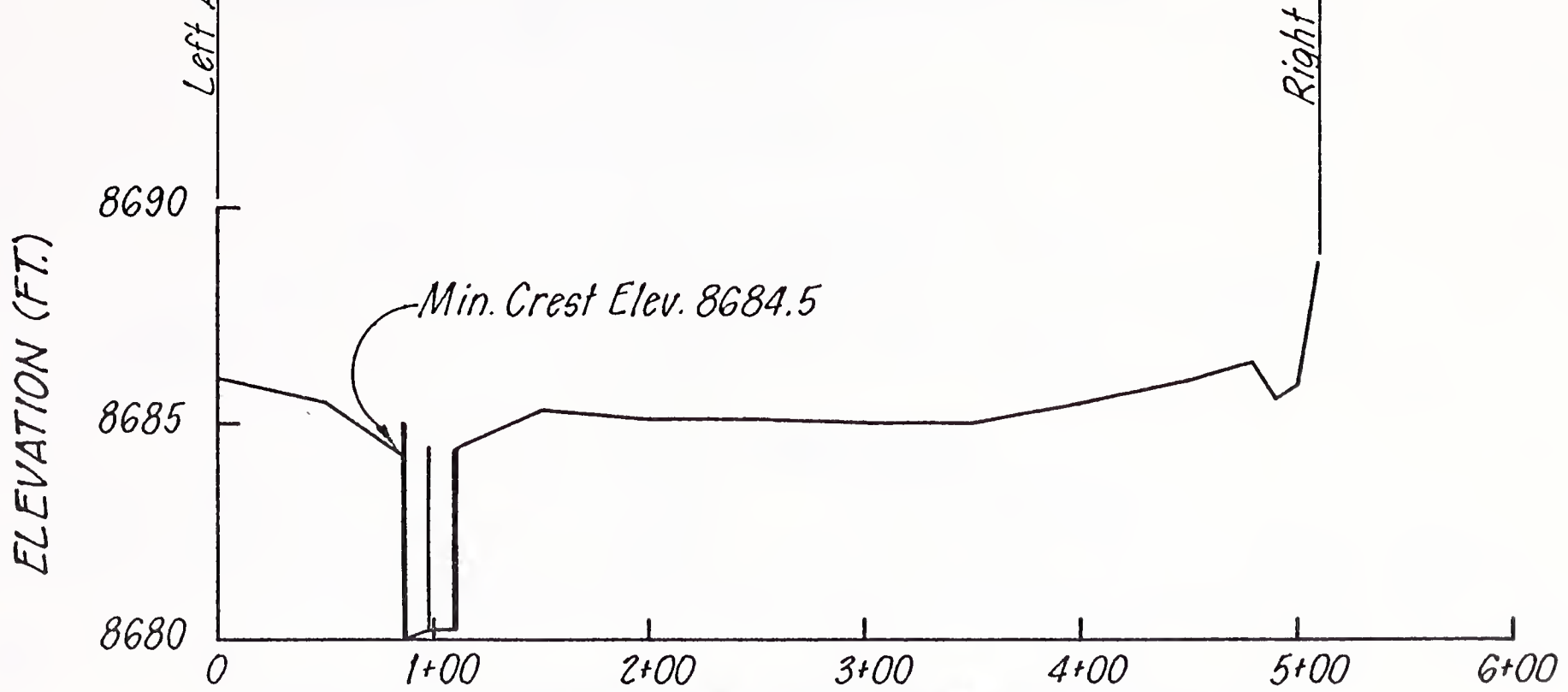
SITE PLAN & VICINITY MAP

PEAR LAKE DAM



PLAN OF DAM

Scale: 1" = 100'

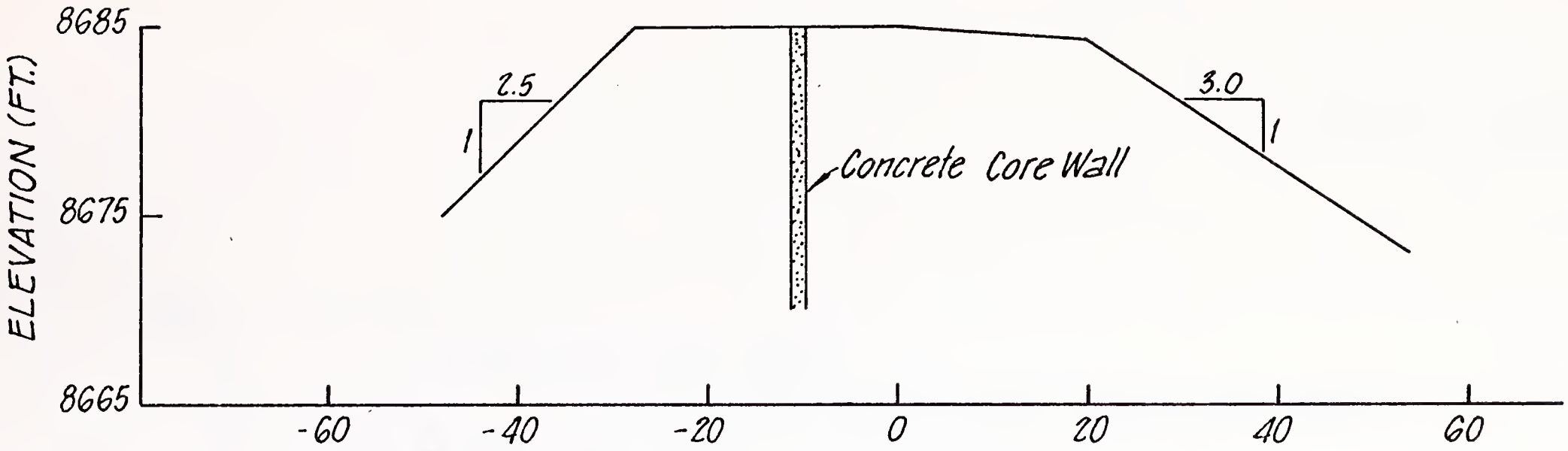


PROFILE OF DAM

Scale: 1" = 100' Horiz.
1" = 5' Vert.

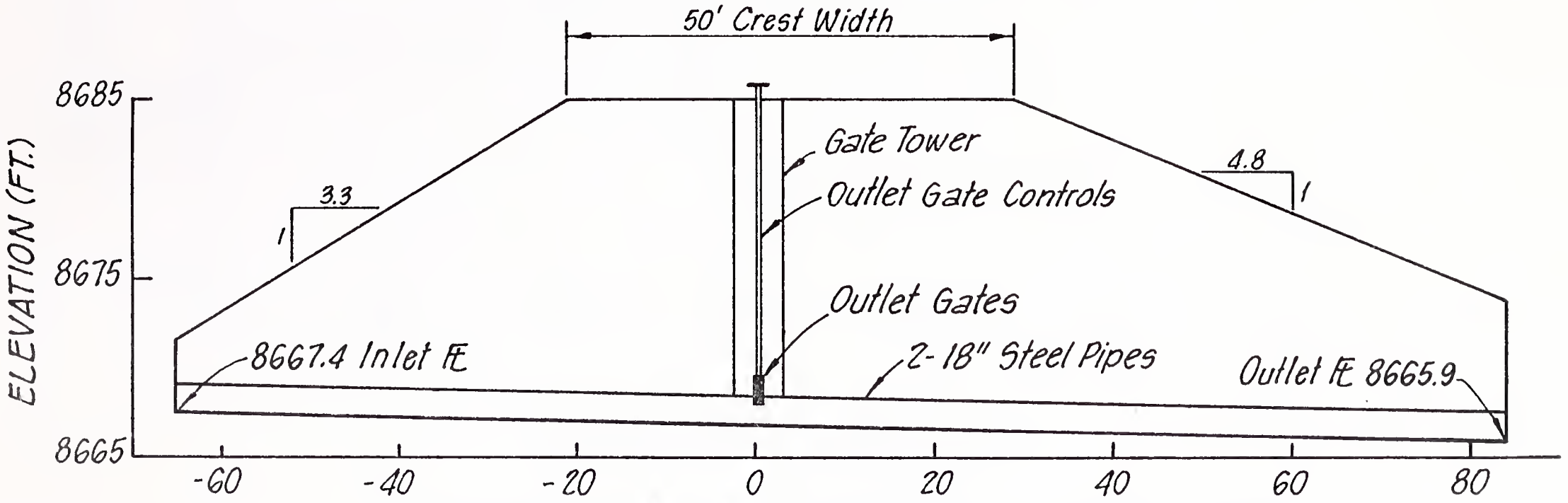
PLATE 2

PEAR LAKE DAM



TYPICAL CROSS-SECTION @ 3+00

Scale: 1" = 20' Horiz.
1" = 10' Vert.

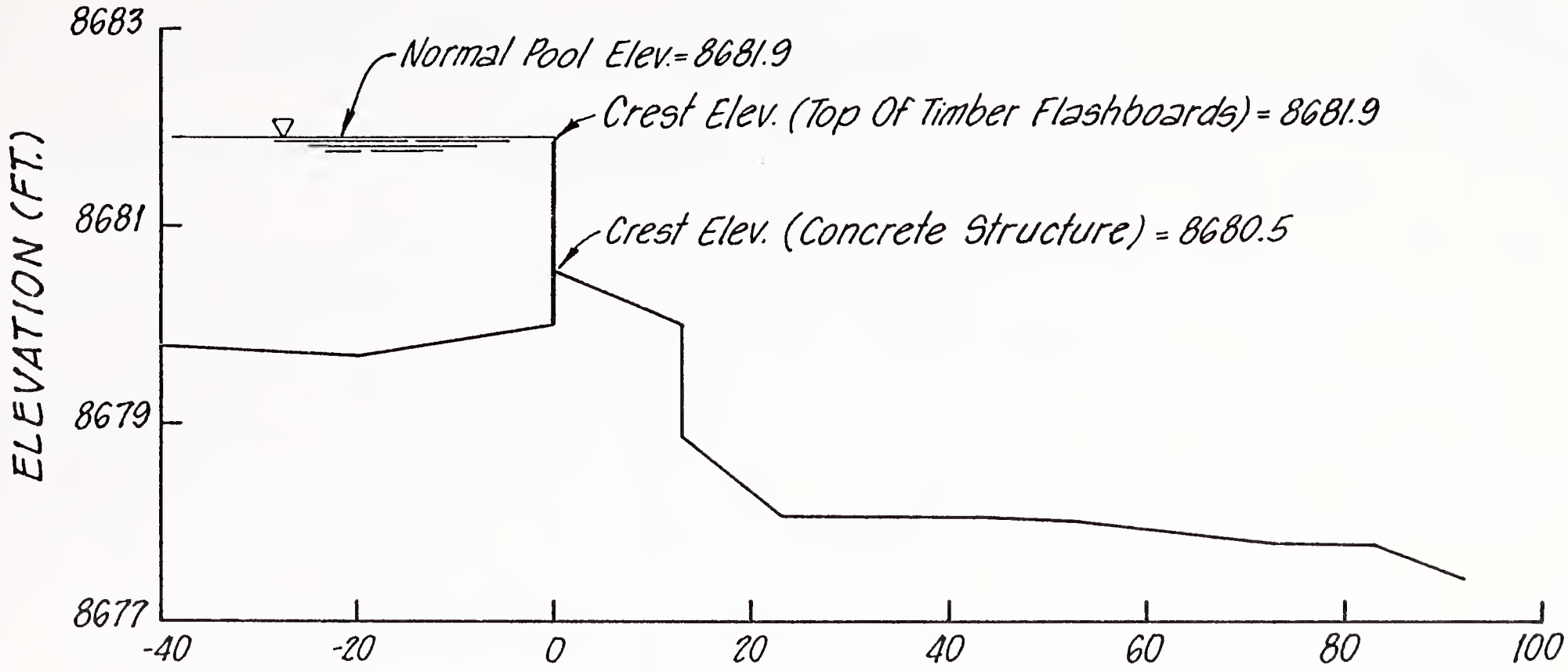


CROSS-SECTION @ OUTLET STRUCTURE

Scale: 1" = 20' Horiz.
1" = 10' Vert.

PLATE 3

PEAR LAKE DAM



SPILLWAY PROFILE

Scale: 1" = 20' Horiz.
1" = 2' Vert.

PLATE 4

SURFACE AREA (ACRES)

80 70 60 50 40 30 20 10 0

8695
8690
8685
8680
8675
8670
8665

ELEVATION (FEET)

Min. Crest Elev. 8684.5

Normal Pool Operating Elev. 8681.9

Storage

Surface Area

0 100 200 300 400 500 600 700 800 900

STORAGE (ACRE-FEET)

PEAR LAKE DAM
RESERVOIR STAGE-AREA & STAGE-STORAGE CURVES

PLATE 5

PEAR LAKE DAM
SPILLWAY DISCHARGE RATING CURVE

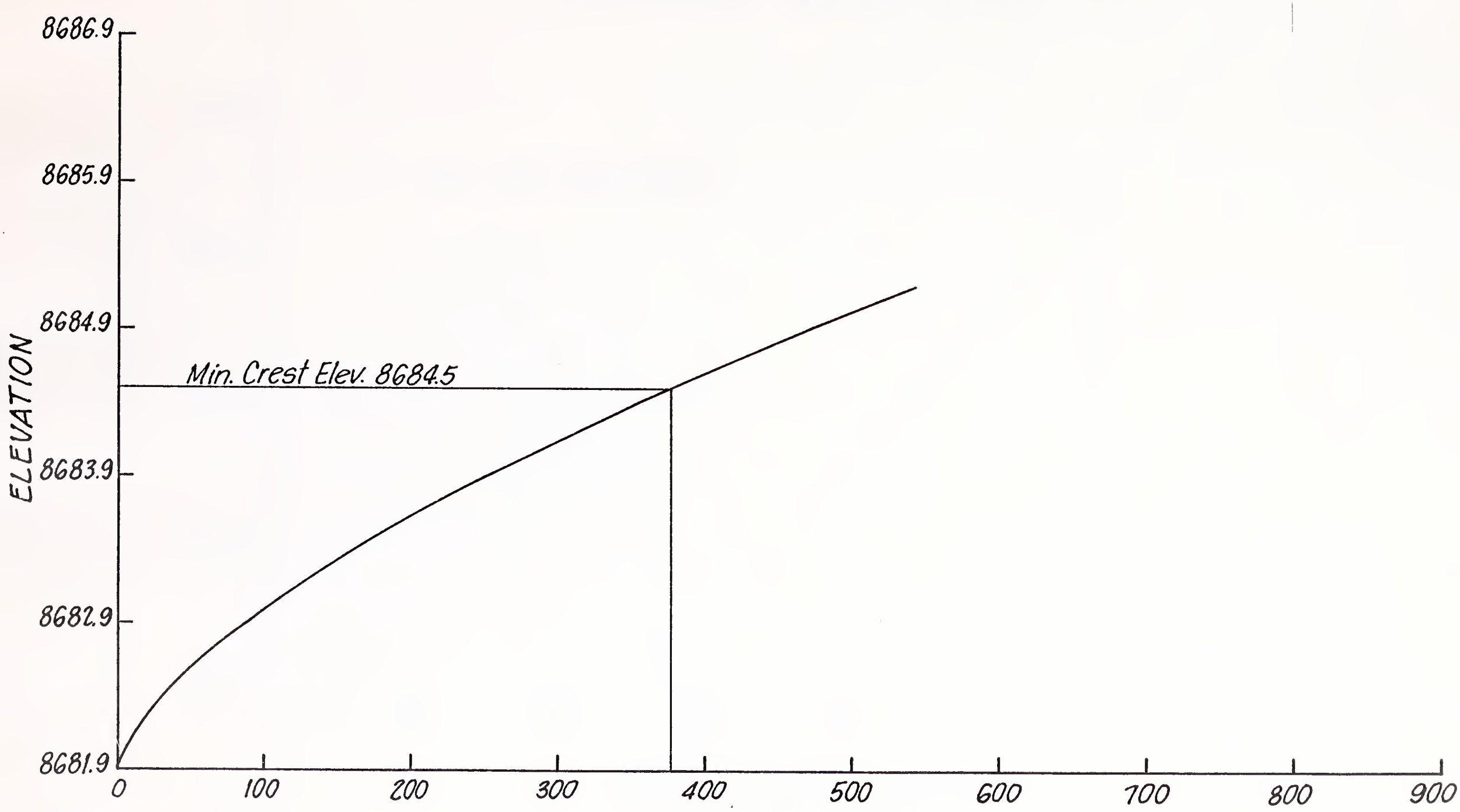


PLATE 6

PEAR LAKE DAM
LOW-LEVEL OUTLET
DISCHARGE RATING CURVE

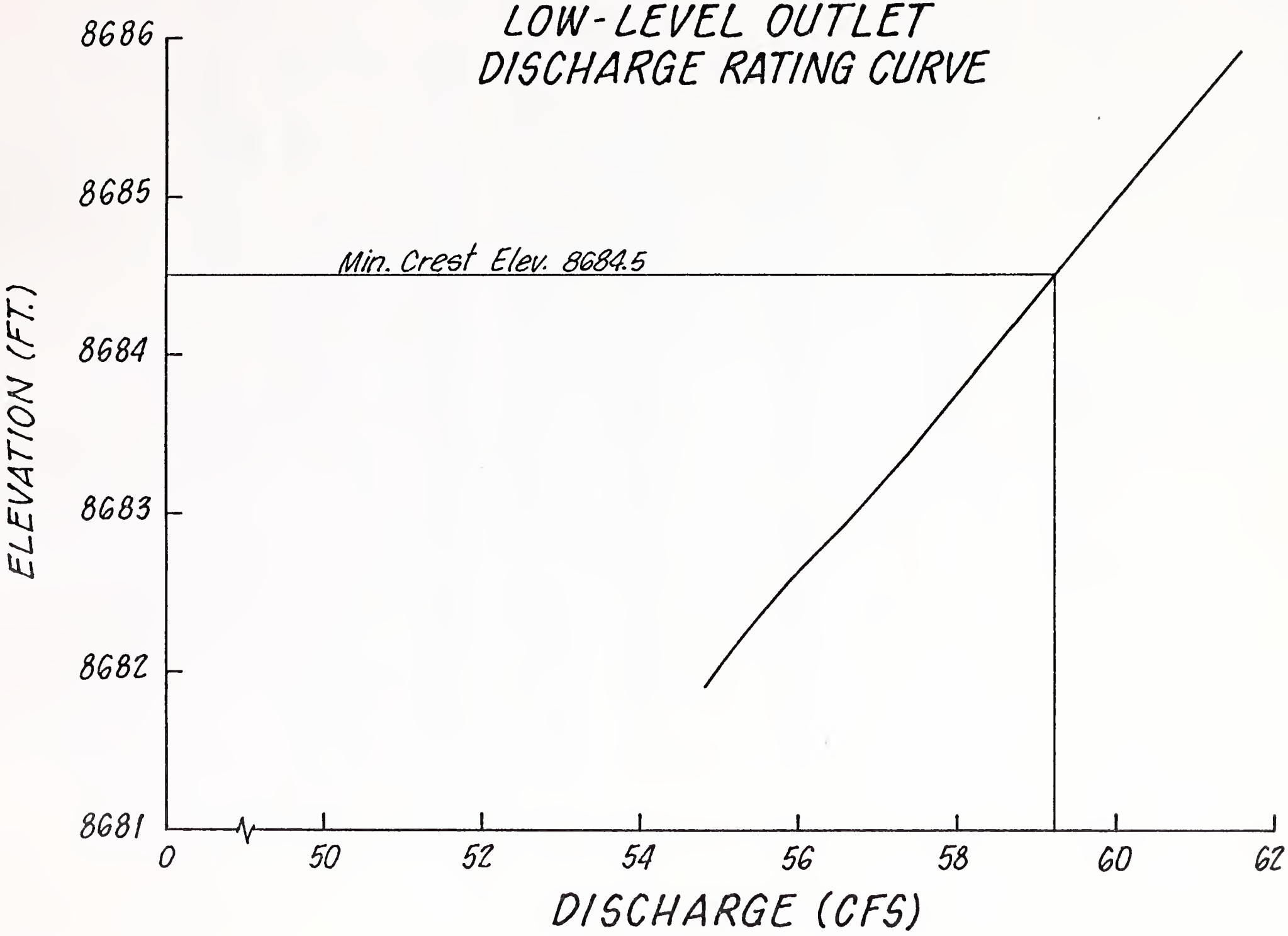


PLATE 7

DEPARTMENT OF NATURAL RESOURCES
AND CONSERVATION
WATER RESOURCES DIVISION

THOMAS L. JUDGE, GOVERNOR

32 SOUTH EWING

STATE OF MONTANA

(406) 449-2872

HELENA, MONTANA 59601

December 11, 1980

Department of the Army
Seattle District, Corps of Engineers
P.O. Box C3755
Seattle, WA 98124

Attn: Ralph Morrison

Re: Hoskins-Western-Sonderegger, Inc. Dam Safety Report on Pear Lake Dam (MT-820).

Dear Ralph:

We have reviewed the above referenced final draft report. We concur with the findings and recommendations and find that it satisfies the criteria of the Phase I report.

Minor editorial comments have been discussed with your staff, and we understand these will be incorporated in the final report.

Thank you for this opportunity to review and comment on the final draft report on Pear Lake Dam.

Sincerely,

Richard L. Bondy

Richard L. Bondy, P.E.
Chief, Engineering Bureau
(406) 449-2864

RB/AT/lj

AN EQUAL OPPORTUNITY EMPLOYER

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FEDERAL BUILDING MISSOULA, MONTANA 59801

7530

Mr. Sidney Knutson, P.E.
Assistant Chief, Engineering Division
Seattle District, Corps of Engineers
P. O. Box C-3755
Seattle, Washington 98124

Dear Mr. Knutson:

We have reviewed the Phase I draft report for Pear Lake Dam and have the following comments.

We agree a more detailed hydrologic analysis, including a breached dam routing, would better define the hazard this dam and others in the Birch Creek drainage present.

Sincerely,

Beryl Johnston

BERYL JOHNSTON
Acting Director
Engineering

IN REPLY REFER TO:

9100 (941)

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
222 North 32nd Street
P.O. Box 30157
Billings, Montana 59107

DEC 16 1980

Mr. Sidney Knutson, P.E.
Asst. Chief, Engineering Division
Corps of Engineers
P.O. Box C-3755
Seattle, Washington 98124

Dear Mr. Knutson:

Final drafts for Phase I Safety Inspection and Evaluation reports for Tub Lake and Dam Project, MT-822; Pear Lake and Dam Project, MT-820; Anchor Lake and Dam Project, MT-821 (South) and MT 1483 (North); and Boot Lake and Dam Project, MT-823 all located in Beaverhead County, Montana have been reviewed.

We have no additional information or comments to add to the draft reports. The opportunity to review the reports is appreciated.

Sincerely yours,

Henry T. Hammersmark

Henry T. Hammersmark
Chief, Branch of Engineering

BEAVERHEAD WATER COMPANY

Dillon, Montana

6825 Highway 91 North
Route 1
Dillon, Montana 59725

Mr. Sidney Knutson, P.E.
Assistant Chief, Engineering Division
Department of the Army
Seattle District, Corps of Engineers
P.O. Box C-3755
Seattle, WA 98124

Subject: Tub, Pear and Boot Lake Dams
MT-822, MT-820, MT-823

Dear Mr. Knutson:

Enclosed for your consideration are our review comments on the Phase I Inspection Report on the subject dams. We hope they will be of value to you in preparation of the final report. They were made in consultation with Stensatter Druyvestein and Associates, Consulting Engineers, Missoula, Montana.

We wish to thank you for the opportunity to make comments and look forward to cooperating in efforts to improve water resource development.

Sincerely,

Garth Taylor, President
Beaverhead Water Company

Enclosures

December 1980

REVIEW COMMENTS
by
Beaverhead Water Company, Dillon, Montana
on
Phase I Inspection Report
Pear Lake Dam
Beaverhead County, Montana

MT-820

The Beaverhead Water Company is grateful for this opportunity to comment on the Phase I Inspection Report on the Pear Lake Dam. We are vitally interested in this dam as productivity of lands owned by members of our Company are highly dependent on safe, reliable water storage. Although maintenance of the dam to supply irrigation water is paramount, it is also important to recognize the additional benefit of providing some flood control storage.

We recognize our obligations for providing safe water storage consistent with reasonable criteria for the size of structures and hazards involved. However, because the West Bench Irrigation District is heavily obligated to the Federal Government for loans on a new gravity sprinkler system, it has very limited available funds. Therefore, it is very important that any required work be really necessary and consistent with actual conditions.

The following comments are made for consideration in preparation of the final report.

I Inspection and Safety Criteria

The value of guidelines for implementation of the National Dam Inspection Program is recognized as being very important. We generally agree with provisions in the "Recommended Guidelines for Safety Inspection of Dams" prepared by the Corps of Engineers. But we feel it is equally important to recognize and remember the basis for use of these guidelines. As noted in the Preface to these guidelines, "Safety must be evaluated in the light of peculiarities

and local conditions at a particular dam... The establishment of rigid criteria or standards is not intended." The Preface further states that the "guidelines are intended to be flexible" and contains the following paragraph:

> "Conditions found during the investigation which do not meet guideline recommendations should be assessed by the investigator as to their import from the standpoint of the involved degree of risk. Many deviations will not compromise project safety and the investigator is expected to identify them in this manner if that is the case. Others will involve various degrees of risk, the proper evaluation of which will afford a basis for priority of subsequent attention and possible remedial action."

Therefore, as will be pointed out in more specific comments, we think that evaluations and recommendations for each dam should be consistent with the particular circumstances.

II Inspection

The primary purpose of Phase I investigations is to identify those dams which may pose hazards to human life or property. This is good. However, we are not pleased with far reaching safety evaluations and costly recommendations based on a brief site visit. We think that if potentially serious conditions exist, or if costly recommendations are made, then they should be made based on a more thorough investigation and analysis by experienced engineering personnel. In this case, they should have a background in high mountain dam construction and hydrology. This is consistent with the intended use of the guidelines.

III Existing Dam

It is important in any investigation and evaluation of a dam to keep in mind the difference between new design criteria and evaluation criteria for an existing structure. In some aspects they are similar or even identical, but in others they are different. For example, slope stability of a dam 75 years old in this case, can be based primarily on actual experience or observation rather than an estimate based on laboratory tests. Here again experience is important as many other dams in Western Montana are constructed of similar or identical soils. As another example, the need for and value of installing and monitoring piezometers is highly questionable.

IV Classification

The hazard potential classification of "significant" is based on "...approximately 2 inhabitable structures located about 10 miles downstream from Boot Lake ..." We question the accuracy of this rating and believe it should be "low". Was a flood routing done past these structures? Were cross sections and elevations taken near these structures to determine if loss of life would be expected if they were occupied? Are they in fact used or inhabited a significant amount of time?

This is highly important as the degree of risk affects spillway capacities, freeboards and other features on these and other dams.

V Hydrology

In general, we believe that the hydrologic analyses performed under this study are inadequate to serve as a basis for any significant changes in the dams, spillways or hazard ratings. We agree that not enough is known about high mountain basin hydrology to accurately predict exact storm or snowmelt runoff. But we don't agree that an ultra conservative approach should be

followed because of this lack of knowledge or data. To begin with, we think a Q_{100} evaluation flow is much more realistic for a low hazard structure such as this. The guidelines recommend Q_{50} to Q_{100}.

With regard to a Probable Maximum Flood (PMF) analysis, to go from Probable Maximum Precipitation (PMP) to PMF with no infiltration or other deductions certainly is conservative, but not necessarily realistic for this situation. Also, the basis for using a 24-hour PMP is unknown and unsupported. Further, we disagree with the inclusion of storage waters from both Tub Lake and Anchor Lake in the inflow hydrograph for this reservoir.

In summary, we think that for small projects such as this one, that appropriate "safe flood rating criteria" should be established at somewhat less than new design criteria. It doesn't seem reasonable to totally ignore the 75 years that this project has experienced.

VI Flood Warning System

Considering the size and remote, unattended location of these dams, and the determination that only "approximately 2" inhabitable structures would be directly affected by a dam failure, the recommendation to "Immediately develop, implement, and periodically test an emergency warning system..." seems totally inappropriate. If there was any advance notice, it would seem that the best plan would be to directly notify anyone living along the stream in person or through the sheriff's department.

VII Maintenance and Repair Recommendations

These are generally acceptable except for items previously covered and for the following:

a. Based on a low hazard rating and a revised hydrologic analysis, the existing spillway flashboardsmay be acceptable. They are important for irrigation water storage so if absolutely necessary, a reduction in height or design modification may be appropriate rather than total removal.

b. It may not be necessary, practical or feasible to remove all root systems from bushes and trees. The extent of work should be determined by an experienced engineer based on a careful inspection and assessment.

c. We do not agree that frequent condition inspections be made whenever water is impounded unless there is a specific purpose and need.

d. Although the construction of inverted filters over two seep areas may be necessary or desirable, we do not agree they are necessary prior to any water storage next spring. In fact, it may be desirable to access the seepage with storage prior to any construction work.

On page 16 it states that "Pear Lake Dam will probably fail when overtopped by flood waters". But on page *ii* it states that "Because the dam crest is about 50 feet wide and also contains a concrete core wall, Pear Lake Dam will probably not fail when overtopped by flood waters." For the reasons given we agree with the later statement.

The remoteness of the site make inspections, maintenance and repairs difficult and expensive, but we agree that improvements can be made in these areas.

Beaverhead Water Company

Garth Taylor, President

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX C-3755
SEATTLE, WASHINGTON 98124

NPSEN-FM

26 January 1981

Garth Taylor, President
Beaverhead Water Company
6825 Highway 91 North
Route 1
Dillon, Montana 59725

Dear Mr. Taylor:

Thank you for providing comments on the draft dam safety reports for your company's dams: Anchor Lake Dams, MT-821 and MT-1493; Tub Lake Dam, MT-822; Boot Lake Dam, MT-823; and Pear Lake Dam, MT-820. Your comments have been considered in preparation of the final reports and all your comments will be appended to the final reports.

I am gratified that you and your company have such a keen interest in dam safety and I share your view about properly maintaining the structures without having to do unnecessary engineering studies or remedial work.

The inspections were conducted by experienced engineers who used the inspection guidelines developed by the Corps of Engineers in consultation with states and other engineering organizations, both within and outside the Government. The guidelines are used as a screening tool to determine if existing dams are in need of further study and/or remedy. The Corps of Engineers has no enforcement authority in implementing report recommendations.

The inspecting engineers used judgement in arriving at the downstream hazard classification for your dams. Because the downstream hazard potential is so important to what a dam's capability must be in controlling floods, we have recommended that additional basin hydraulic and hydrology studies be undertaken by you to better define the interrelationships of your dams and the potential hazards of dam failure and to base each project's needed flood handling capability on that more in-depth study. This study should form the basis for all safety-related activities at each site. Both the United States Forest Service and the Montana Department of Natural Resources and Conservation's Engineering Bureau concur in this approach.

NPSEN-FM
Garth Taylor, President

Your concern about our recommendations on downstream warning plans is well taken. Our intent here is to have some workable plan to promptly notify the downstream residents and interests in case of dam distress. We are not advocating any alarm system such as sirens, etc. Your idea of having the affected parties notified by the Sheriff or someone designated for that purpose is the kind of plan we meant, but it should be a formal written and coordinated plan showing who has responsibility.

Sincerely yours,

Sidney Knutson